Leveraging Geospatial Intelligence (GEOINT) in Mission Command

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GEOINT provides the decision-maker or commander the ability to attain shared understanding of the operational environment. Joint and Army planning both recognize GEOINT but do not provide a vehicle to reveal its capabilities or how those capabilities can assist the commander with situational understanding. Joint and Army planners in COCOMs must follow NORTHCOM's lead and exploit GEOINT modeling capabilities in preparing for new and emerging threats. The employment of GEOINT modeling capabilities provides decision-makers the ability to visualize the environment prior to conducting operations. The military planners' limited understanding of GEOINT's capabilities and their tendency to focus on the limited number of useful data sources retards exploitation of geospatial intelligence capabilities in military operations planning. The value of GEOINT lies in its ability to bring analysis to inform all stages of commander visualization in mission command.

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Abstract

LEVERAGING GEOSPATIAL INTELLIGENCE (GEOINT) IN THE COGNITIVE HIERARCHY OF MISSION COMMAND by MAJ Andy Sanchez, U.S. Army, 58 pages.

The federal government response to Hurricane Katrina demonstrated a vital need for the military to improve the process for assessment, response, and decision-making for all organizations involved. Geospatial Intelligence (GEOINT) is an emerging intelligence discipline that provides detailed data analysis, an assessment of the operational environment, and a means to investigate problems that may emerge. GEOINT is the exploitation and analysis of imagery and geospatial information to describe, assess, and visually depict physical features and geographically referenced activities. By examining the use of geospatial information systems by civilian organizations use of during Hurricane Katrina, it was possible to observe that the U.S. Combatant Commands are underutilizing GEOINT's potential as a tool for information analysis. Faced with new and complex problems, the military must adapt not only its methods for understanding complex problems but also must integrate new technologies to inform Mission Command.

GEOINT provides the decision-maker or commander the ability to attain shared understanding of the operational environment. Joint and Army planning both recognize GEOINT but do not provide a vehicle to reveal its capabilities or how those capabilities can assist the commander with situational understanding. Joint and Army planners in COCOMs must follow NORTHCOM's lead and exploit GEOINT modeling capabilities in preparing for new and emerging threats. The employment of GEOINT modeling capabilities provides decision-makers the ability to visualize the environment prior to conducting operations. The military planners' limited understanding of GEOINT's capabilities and their tendency to focus on the limited number of useful data sources retards exploitation of geospatial intelligence capabilities in military operations planning. The value of GEOINT lies in its ability to bring analysis to inform all stages of commander visualization in mission command.

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Introduction

The recent wars in Iraq and Afghanistan and the federal government response to Hurricane Katrina have demonstrated a vital need for the military to improve the process for assessment, response, and decision-making. Concepts such as operational art and Design claim to provide "a way" to frame the operational problem, but neither method actually improve the commander's ability to understand the situation. Some processes, such as operational art and design, fall short of answering important questions and translate easily into missions that soldiers can execute. Military commands and staffs start situation assessment by examining a map. Enter Geospatial Intelligence or (GEOINT); an emerging intelligence discipline that provides detailed data analysis, an assessment of the operational environment, and a means to investigate problems that may emerge. GEOINT is the exploitation and analysis of imagery and geospatial information to describe, assess, and visually depict physical features and geographically referenced activities on the Earth.[1] Faced with new and complex problems, the military must adapt not only its methods for understanding complex problems but also must integrate new technologies to inform the cognitive hierarchy of Mission Command.

Warfare is complex. Add to the conventional concept of warfare, the unpredictable components of culture, religion, political ideology, and friction[2] and the complex military problem evolves into an ill-structured problem.[3] Emerging planning methods such as Design seek to frame a complex problem through a rigorous form of questioning that can ultimately lead to a

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[1] Department of Defense. Joint Publication 2-03. *Geospatial Intelligence Support to Joint Operations*. 31 March 2007.pg vii

[2] Carl Von Clausewitz (1976, rev.1984). *On War*. edited and translated by Michael Howard and Peter Paret. Princeton: Princeton University Press. Clausewitz refers the friction of war that will ultimately keep war limited, unpredictable, and dangerous.

[3] US Army Training and Doctrine Command, TRADOC Pamphlet 525-5-500, *Commander's Appreciation and Campaign Design*, Version 1.0 (Fort Monroe, VA: GPO, 28 January 2008), 6. An Ill-Structured Problem is the most interactively complex, non-linear, and chaotic –and therefore the most challenging. Unlike well- or medium-structured problems, professionals will disagree about how to solve this type of problem, what should be the end state, and whether the desired end state is even achievable.

theory of action. Where Design falls short is through its neglect of GEOINT's proven methods. When used appropriately, GEOINT can eliminate the need for planning assumptions by revealing facts and enabling the assessment of alternative responses. GEOINT technology enables the military, national intelligence, and engineering communities to interact simultaneously to develop a two or three dimensional digital map displays of large amounts of layered data. The collaborative data display facilitates collaborative analysis. GEOINT permits detailed data analysis that supports the decision maker by providing him better situational understanding. Unfortunately, Army planners do not understand the important role geographic information systems can serve in informing Battle Command or joint operations planning.

In the contemporary operating environment, GEOINT can be employed at all levels of war. GEOINT is most useful at the tactical level, for planning. At the tactical level GEOINT merges imagery intelligence with geophysical maps. The military customer of GEOINT generally expects the analyst to provide him a printed map or some form of two or three dimensional digital display. In most cases the value-added by GEOINT is embedded in the finished product's imagery and graphic intelligence. But GEOINT technology is evolving quickly in the private and civilian government sectors to support business ventures and government agencies. The military is missing opportunities to capitalize on GEOINT technology by not incorporating its capabilities into the warfighting community.[4] Lt. General Clapper has observed,

> GEOINT is about more than pictures. GEOINT makes possible in-depth assessments and judgments based on the information that is gleaned from visual depictions. In short, GEOINT is more than imagery, maps, charts and digital displays showing where the bad guys are. GEOINT at its best is the analysis that results from the blending of all of the above into a dynamic, composite view of features or activities—natural or manmade—on Earth.[5]

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[4] Jim Youker. "Geo-enabled PDF Usher In a New Era." *GIS Development: The Global Geospatial Magazine*. Volume 12, Issue 10. October 2008.pg 3

[5] James R. Clapper, Jr., Lieutenant General. 2004. "Imagine the power of GEOINT," *Pathfinder:The Geospatial Intelligence Magazine.*May-June. National Geospatial Intelligence Agency.pg 6.

Although Lieutenant General Clapper's example illustrates one GEOINT use, it is only a small portion of GEOINT's capabilities. GEOINT's true potential lies in its ability to predict situations through the construction of analytical models. The models can provide a commander and his planning team means by which to forecast changes and effects in their area of operation to provide context and improve understanding. Brigadier General (Ret) Huba Wass de Czege emphasizes the importance of emerging methods to assist commanders to achieve better understanding. He wrote

> Operational artists at all levels need new conceptual tools commensurate to today's demands. Conceptual aids derived from old, industrial-age analogies are not up to the mental gymnastics demanded by 21st –century missions. Because operational environments evince increasingly dynamic complexity, commanders are looking for, and are in need of, help.[6]

GIS modeling tools are that help. Modeling is made possible through the employment of software components within a GEOINT program. The program provides a standard platform for spatial analysis, data management, and mapping. Used properly, GEOINT provides the commander and his planning team with useful predictions derived from models that support assessments and creates a more accurate projection of the situation and the operational environment.

Private enterprise and civil government communities have used geographic information systems for several years. The capabilities of geographic information systems[7] used during disaster response and homeland security planning are just beginning to be exploited.

> Geographic information systems integrate hardware, software, and data for capturing, managing, analyzing, and displaying all forms of geographically referenced information. Geographic information systems allows a user to view, understand, question, interpret, and visualize data in many ways that reveal relationships, patterns, and trends. When displayed in map, report, or chart format, GIS allows the user to answer questions and solve problems by examining data rapidly and collectively.[8]

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[6] Huba Wass de Czege, Brigadier General (Ret), U.S. Army. "Systemic Operational Design: Learning and Adapting in Complex Missions." *Military Review* January-February 2009. pg 2.

[7] ESRI. *GIS.com.* October 1, 2008. http://www.gis.com/whatisgis/ (accessed April 24, 2009).

[8] Ibid, 1

A geographic information system is an embedded software capability of the GEOINT process. Unfortunately, the military fails to reference geographic information systems as a vital component of the GEOINT process in Joint or Army Doctrine.

If the military's use of geographic information during the response to Hurricane Katrina is compared with geographic information systems use by civilian responders, it is possible to identify the military planner's limited conception of geographic information. The employment of GEOINT modeling capabilities simply recognizes the importance of testing an initial hypothesis and assumptions during mission analysis. Contemporary application suggests the underutilization of GEOINT's full potential as a product for information analysis by COCOM and Army planning staffs. If NORTHCOM's expanded use of geospatial information systems for planning and disaster response is examined, it is possible to identify the key elements of mission command as outline in FM 6-0 that are supported by geospatial intelligence. The military planners limited understanding of GEOINT's capabilities and a tendency to focus on the limited number of useful data sources retards exploitation of geospatial intelligence capabilities in military operations planning. Therefore, a commander's visualization aided and enhanced with geographic information systems can significantly improve mission command.

The potential value of GEOINT lies in its ability to bring analysis to inform all stages of commander visualization in mission command. According to Chapter 4 of Field Manual 6-0 Mission Command, commander's visualization consists of the mental process of achieving a clear understanding of the force's current state with relation to the enemy and environment. Commanders continuously visualize military operations through situational understanding, operations planning, execution, and assessing.[9] First, he must develop situational understanding. That is, the commander must understand the situation at the outset of a planning effort.

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[9] Department of the Army. *Field Manual 6-0: Mission Command.* Washington, D.C.: Department of the Army, 2003. p.4-0.

GEOINT's robust database can rapidly filter relevant from irrelevant data to answer specific questions a commander must answer to attain situational understanding. Processed data is layered on a map and shared with subordinate units for further analysis. The more accurate the data and information, the faster a commander achieves understanding of his environment.

Second, the commanders must visualize where to go, how operations will unfold, and understand how well his forces are doing. Visualization in operations begins with planning and continues throughout the execution until the force accomplishes the mission. The commander focuses the staff's planning efforts by providing intent, planning guidance, and commander critical information requirements. GEOINT technology can assist the commander and staff, through modeling and simulation to determine how the enemy views its operations in time and space. Next, visualization in execution represents the commander's assessment of how well operations are succeeding and if any adjustments are needed improve performance or achieve success. GEOINT's embedded common operating picture provides the commander the ability to keep visualization current.

Finally, assessment occurs during all stages of visualization in mission command. The commander relies initially on personal experience, the staff, and assessments from units executing the mission. GEOINT's ability to organize data, query specific information, and provide trend analysis aids the continuous process of assessment throughout all stages of visualization. The GEOINT process, enabled by the detailed analysis of geographic information systems, provides the commander with the science that complements the commander's employment of the art of war. Geographic information systems assist a commander's visualization by providing software tools that permit a complex, multi-dimensional data display that more accurately represents the situation and permits estimates, forecasts, and prediction. GEOINT aids Mission Command by establishing a basis for shared understanding and the ability to analyze layered data to facilitate parallel planning for subordinate units.

What is GEOINT?

Geospatial intelligence (GEOINT) supports joint forces in their ability to respond to threats around the world. Geo-referenced visual data products serve as a foundation and common frame of reference for any joint operation.[10] GEOINT is the exploitation and analysis of imagery and geospatial information to describe, assess, and visually depict physical features and geographically referenced activities on the Earth.[11] GEOINT consists of imagery, imagery intelligence (IMINT), and geospatial information.[12] GEOINT is currently employed at the strategic, operational, tactical levels to support the military, national security and homeland security planners. The United States Army Corps of Engineers and members of the Intelligence Community also use GEOINT to inform private and public sector decision makers.[13] People familiar with GEOINT, normally see mapping or some kind of imagery product. GEOINT products, however, combine imagery with layered data from other intelligence disciplines such as Human intelligence (HUMINT), Signal Intelligence (SIGINT), Measurement and Signatures Intelligence (MASINT), and Open-Source Intelligence (OSINT).[14] This combination provides users with a comprehensive and continuously growing source of information to produce digital map products. The information is an integral part of the map product and can be accessed, shared, and analyzed by multiple users in a timely manner. Figure 1 depicts how GEOINT is a part of the comprehensive response to the integration of the intelligence process.

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[10] JP 2-03, vii
[11] Ibid, vii
[12] Ibid, vii
[13] Ibid ,7
[14] Ibid, 9

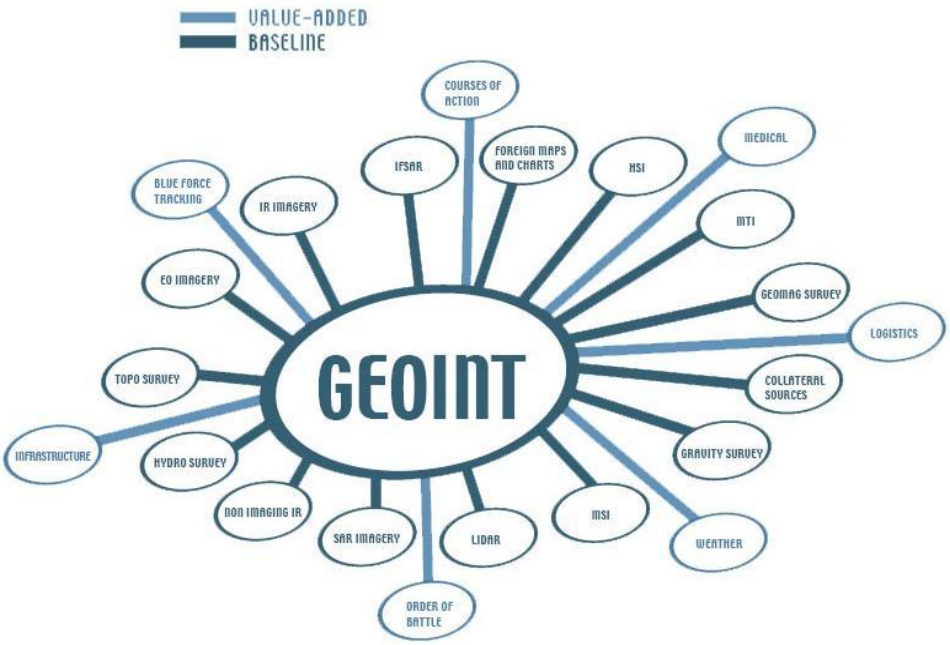

Figure 1. GEOINT's comprehensive integration of intelligence and imagery databases

The military does not conduct GEOINT operations in isolation. GEOINT consists of many ongoing operations and activities across the Department of Defense (DOD).[15] In military operations GEOINT fuse multiple components of intelligence and imagery intelligence.The GEOINT product serves as an interactive geospatial framework to aid the commander's situational understanding of the environment. GEOINT assists the commander efforts to visualize the operational situation during planning and execution. By organizing data and information into map layers the critical components of the operational environment as outlined in FM 3-0, are visually depicted on a digital map. The ability to integrate data from the Political, Military, Economic, Social, Information, Infrastructure, Physical environment and Time (PMESII-PT)[16] in

[15] Department of the Army, Headquarters. FM 2-0 *Intelligence w/change 1*. 2004

[16] Department of the Army, Headquarters. FM 3-0 *Operations.* 27 February 2008. pg 1-5. Operational Variables allow planners to describe the operational environment and the population's impact on said variables. The Operational Variables consist of the poltical, military, economic, social, information, infrastructure and can include the physical environment and time. Since a population's impact on military operations are unique from one theater to the next it is important that Operational Variables be analyzed within the context of the specific environment.

a layered data-base linked to a digital map assists the commander in attaining situational understanding. When combined with an interactive map, the aforementioned components of the operational environment enable insight into to present and future operations. GEOINT thereforeenhances the ability to anticipate requirements through accurate estimates, forecasts, and trend analysis. For example, a commander operating within a neighborhood of Iraq is attempting to understand why criminal activity is increasing in a particular part of his area of responsibility. Using GEOINT layered data on an existing digital map he can ask his intelligence analyst to sort criminal activity by type, date, time, and location. He can then organize this data further by sorting and analyzing the same criminal activity to see if it may relate to a potential disparity in income levels, or possible differences in religious and political affiliations between difference sections of the populace.

The GEOINT discipline is the specialized field of practice within the broader profession of intelligence. The Department of Defense recognizes the potential capability of geographic information systems technology to provide a richer, more detailed, and useful picture. GEOINT can be collected on a specific area and organized by data layers into categories such as infrastructure, and demographic and cultural information. The data layers combine with a multi-functional two or three dimensional map product that multiple users in different location can access simultaneously. GEOINT provides the commander with a three-dimensional context, in which the decision maker is more likely to comprehend divergent pieces of information, reach a decision, and initiate action.[17] When used in this capacity, GEOINT enables the commander's visualization in operations, execution, and assessment.

[17] John Doty. Geospatial Intelligence: "An Emerging Discipline in National Intelligence with an Important Security Assistance Role." *The DISAM Journal,* Spring 2005. pg 5)

GEOINT consists of four fundamental components: the discipline of GEOINT, the data that comprise GEOINT, the process used to develop GEOINT products, and the products derived from GEOINT:

> 1.Discipline. The GEOINT discipline encompasses all activities involved in the planning, collection, processing, analysis, exploitation, and dissemination of geospatial information to gain intelligence about the operational environment, visually depict of this information, and fuse the visual information with other information through analysis and visualization processes.
>
> 2. Data. GEOINT is developed from the same geospatially-derived data used to create geospatial information, imagery, and IMINT. The full capabilities of GEOINT are only realized when two or more types of data are combined and analyzed to create a comprehensive GEOINT product.
>
> 3. Process. The analytic methodology used by NGA is known as GEOINT preparation of the environment (GPE). GPE supports joint intelligence preparation of the operational environment (JIPOE). It is a proven methodology and, of equal importance, it provides a common frame of reference and language between military and civilian personnel.
>
> 4. Products. GEOINT products range from standard geospatial data-derived products, maps, and imagery to specialized products that incorporate data from multiple types of advanced sensors and use four dimensions.[18]

The data component of GEOINT aids the commander in the process of decision making. *Data* answers the "so what" of the commander's guidance and intent and the commander's critical information requirements. Aggregate raw data becomes *information* through management (organization and discipline) which organizes the data into systems, analysis, processing, and exploitation. Staff members then place information within the context of their experience, and the information becomes *knowledge*. The sum of the knowledge, over time and within a spatial context, creates within the mind of the commander the *understanding* required to make effective decisions.[19] The value of GEOINT lies in its ability to take geographic location, the most simple but fundamental component of everyday life, and add geographic relevant data such as the operational variables identified as PMESII-PT to describe a specific environment. Once the data

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[18] National System for Geospatial Intelligence *(GEOINT) Basic Doctrine Version 1.0*, NGA. 2006
[19] Ibid, 16

is incorporated into an interactive map the visual display improves the commander's visualization throughout the military decision making process.

GEOINT in Joint Operations

Geospatial intelligence support has only recently appeared in the joint doctrine and is not addressed in Army operations doctrine. GEOINT provides an analytical framework for geo-reference battlefield information and displays the results in a common picture of strategic, operational, and tactical environments. Joint Publication 2-03 *Geospatial Intelligence Support to Joint Operations* states that Combatant Commands (COCOMs) utilize GEOINT to develop area and point targets while supporting the planning and execution of joint operations. Fundamental to GEOINT's integration in joint operations is the establishment of a Joint Operations Intelligence Cell (JOIC). The JOIC, integrates and employs GEOINT capabilities in support of planning and execution of Joint Operations.[20] Although Joint Publication 2-03 establishes a method for employing GEOINT capabilities, the manual provides no specific guidance on how to make best use of geospatial intelligence. GEOINT has the potential to provide the base from which a commander and his staff can gain shared understanding of the operational environment.

GEOINT provides the framework for intelligence preparation of the battlefield and planning before, during, and after a conflict. The GEOINT cell assigned to combatant commands coordinates all GEOINT requirements within the area of responsibility. Supporting commands or components additionally execute theater and mission-specific GEOINT requirements in support of COCOMs to enable a common operating picture (COP) with a GEOINT framework.[21] Geospatial intelligence provides the commander and staff with a visual picture of the battle space. The COP is essential for a commander's visualization in execution. Subordinate units sharing a

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Department of Defense. *Joint Publication 2-03. Geospatial Intelligence Support to Joint Operations*. 31 March 2007.pp x-xi.

[21] JP 2-03, II-4.

COP update data regularly to ensure data is available for all adjacent units to access and analyze. Additionally, GEOINT's COP provides a commander with situational understanding within the commander's visualization of the environment. GEOINT, therefore, is the major source of content for the common operational picture and the primary means to visualize it.[22] GEOINT establishes a foundation that enables multiple organizations to conduct future planning and execute missions through an integrated product that facilitates information sharing and combined situational awareness. Situational awareness is the process of knowing and understanding what is happening around you and predicting how it will change with time.[23]

The geospatial intelligence preparation of the environment (GPE) analytic method provides GEOINT support to the joint intelligence preparation of the operational environment process. That process consists of the following steps: define the environment, describe influences of the environment, assess threats and hazards, and develop analytic conclusions.[24]The aforementioned list conveniently overlays the tested and proven methods of the Joint Operations Planning Process (JOPP) and the Military Decision Making Process (MDMP) as outlined in JP 5-0 and FM 5-0, respectively.[25] GEOINT base doctrine mirrors both JOPP and MDMP mission analysis processes to facilitate communication between the staff member and the GEOINT analyst. Following the JOPP or MDMP planning construct allows the GEOINT analyst to anticipate potential questions from a commander or staff member. Like IPB, GEOINT provides a way to achieved shared understanding about the environment. Unlike IPB, GEOINT takes this process a step further by capturing the information into an interactive map, layered with all the

[22] Dan Raducanu "Romania Provides Real-Time GEOINT in Iraq." *Pathfinder-The Geospatial Intelligence Magazine*, NGA, January/February 2006 pg, 3

[23] Ibid, 4

[24] JP 2-03, I-5

[25] Ibid, I-8

elements of PMESII-PT.[26] While systematic, the processes for defining the environment and developing analytic conclusions are more concerned with the analysis of data

GEOINT serves as an excellent tool for assisting the commander's visualization in operations.. Through detailed data analysis, GEOINT defines the environment by determining how an environment will impact operations. For example, during course of action analysis, the commander may choose to analyze the impacts on, both friendly and enemy forces. With proper inputs, GEOINT can model and assess how terrain and weather alters the movements of both friendly and enemy units during course of action analysis. The data recorded can inform elements of operational design, such as culmination points and tempo. In this capacity, GEOINT analysis supports the development of evaluation criteria with quantifiable information. Geospatial intelligence modeling capabilities provide powerful predictive tools for Intelligence Preparation of the Battlespace, giving Joint Force and Component Commanders decision superiority[27]

A partnership between the National Geospatial Intelligence Agency (NGA) and the United States Joint Forces Command (USJFCOM) improves the process of GEOINT integration into military operations.[28] The partnership between NGA and USJFCOM, titled Joint GEOINT Activity (JGA), emphasizes collaboration vertically throughout all echelons from strategic to tactical as well as horizontally with all members of the National System Geospatial Intelligence (NSG).[29] Scene visualization is central to this partnership; the use of imagery and graphic data plus other information keyed to a single frame of reference. [30] Decision makers, commanders, planners, or implementers use GEOINT's expanding capability to visualize events in three-

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[26] FM 3-0 *Operations.* 4-1. The elements of combat power are how a commander conceptualizes his capabilities they include the six warfighting functions of movement and maneuver, intelligence, fires, sustainment, command and control, protection and integrate information and leadership.

[27] Raducanu, 3

[28] Barrowman, 16 2007

[29] Ibid, 16

[30] Doty, 13

dimensional space and act, as needed.[31] Combining data from many different sources opens doors to collaboration in ways among analysts, operators, and many others.[32] The GEOINT Online initiative furthers the integration between the Joint community, the interagency, and NGA.[33] The union of these organizations exploits Web 2.0[34] systems and technologies that enable users to discover and generate their own geospatial intelligence products in a secure environment.[35]A GEOINT database enabled by Web 2.0 draws information from specialized legacy systems without requiring their consolidation, allowing the NGA to focus on enabling services.[36] The GEOINT Online initiative gives GEOINT users an unprecedented "reachback" capability to exploit the expertise of multiple analysts within the NGA. Reachback, in joint doctrine, refers to a situation where resources, capabilities and expertise are at a physical distance from the area of interest, supporting the people in the area to perform their tasks.[37] Reachback is the process of obtaining products, services, and applications, or forces, or equipment, or material from organizations not forward deployed.[38] The NGA's customer-oriented approach will additionally improve the abilities of current GEOINT users through information sharing while introducing new users to the capabilities and potential of GEOINT products and services.

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[31] Ibid, 13

[32] Ibid, 13

[33] National Geospatial Agency. GEOINT Online. http://www1.nga.mil/GEOINTOnline/Pages/GEOINTOnlineOverview.aspx. accessed 16 February 2008 GEOINT Online is a grouping of web-based capabilties for an on demand discovery of and access to GEOINT content, services, expertise, and support—simply stated integrated discovery means that a user will be able to browse and search all NGA holdings in regard to GEOINT products.

[34] Timothy Reilly. "What is Web 2.0: Design Patterns and Business Models for the Next Generation of Software?" 9 September 2005. http://www.oreillynet.com/pub/a/oreilly/tim/news/2005/09/30/what-is-web-20.html Accessed 18 March 2009. Web 2.0 is consists of dynamic content that can be gathered from multiple sources in real time and assembled on a single Web page. Web 2.0 content enables blogging, web logging, and resource sharing, which allows users to share, edit, and update information within single or multiple databases.

[35] Robert K. Ackerman. "Geospatial Intelligence Enters New Era." *SIGNAL Magazine*. June 2008. pg 35

[36] Ibid, 35

[37] Department of Defense, Headquarters. JP 1-02 *DOD Dictionary of Military and Associated Terms.* Joint Doctrine Division, J-7. 2007)

[38] Ibid, J-7

GEOINT's ability to inform all stages of a commander's visualization in mission command may have provided local, state, and federal officials the ability to synchronize efforts in response to Hurricane Katrina on August 29, 2005. What follows is a case study of that reveals the limited use of GEOINT during the 2005 disaster and how GEOINT might have improved the response.

Examining Hurricane Katrina: A Case Study

Hurricane Katrina remains one of the most destructive storms in U.S. history. Most published works that recount Hurricane Katrina's landfall on 29 August 2005 focus on the government's failure to respond in a timely manner to ease the suffering of American citizens caught in the Hurricane's path.[39] The government failed the various agencies involved in disaster response and consequence management by not coordinating a unified effort. In response, the School of Advanced Military Studies (SAMS) established SAMS Planning Group Katrina (SPG-K) in September of 2005.[40] SPG-K recommended the creation of an operational level for local, state, and federal agencies when required to conduct domestic incident management.[41] The recommendations of Department of Homeland Security's (DHS) focused solely on improving the working relationships and a unity of effort among all levels of government.[42] Although useful, this approach fails to address a tangible method achieve results that will improve governmental response within the National Response Framework. GEOINT's modeling capabilities provide that method.Planners must communicate potential requirements to decision makers using GEOINT modeling capabilities to visualize, predict, and understand a hurricane's impacts post landfall. In particular, GEOINT's modeling capability can synchronize the government's response better

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[39] Department of Homeland Security, "The Federal Response to Hurricane Katrina." Washington, DC. February 2006. pg 3

[40] Katrina, SAMS Planning Group -. *Weathering Katrina: The Debate for An Operational Level Framework for Domestic Incident Management.* Monograph, Fort Leavenworth, KS: School of Advanced Military Studies, December 31, 2008. pg. 3

[41] Ibid, 3

[42] Ibid, 4

across all levels and facilitates unity of effort by reducing redundancy. GEOINT is a basic analytical product that can ensure the efforts of both governmental agencies and civilian volunteers complement each other. Using GEOINT to build situational understanding of a hurricane's impact on a community allows the decision makers to focus on improving the efficiency of each supporting agency. While GEOINT capabilities can improve decision-makers ability to respond to disasters, it is important to understand how GEOINT was employed before and after Hurricane Katrina. Examining GEOINT's employment prior to and just before landfall reveals why decision makers did not fully understand the situation because the decision makers did not understand what GEOINT could provide.

GEOINT's Role: Not Much Went Right

The NGA was one of the few federal agencies whose timely support made the process of recovery easier for all organizations involved in disaster response and consequence management.[43] The National Geospatial-Intelligence Agency (NGA) started collecting key infrastructure-related information (i.e. airports, hospitals, police stations, emergency operations centers, highways, and schools) well in advance of the hurricane's landfall. NGA's initiativegot valuable information into the hands of Federal, State, and local first responders in the affected region.[44] Because the local and state agencies did not understand their role within the National Response Framework they failed to request NGA support for their preparations.[45] Fortunately, for local and state officials, NGA anticipated the requirements and sent the right products to the right people in a timely manner.

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[43] DHS. "The Federal Response to Hurricane Katrina: Lessons Learned." Stated in the DHS report under the section"Things the went well." The NGA support to agencies at all levels before, during, and after Hurricane Katrina made the process of recovery easier for all aforementioned agencies involved.

[44] Ibid, 131

[45] U.S. Department of Homeland Security, *National Response Plan (NRP).* Washington, D.C., 2004 pg 8-9

> During the storm's approach, NGA positioned analysts and mobile systems in the affected areas, providing expertise and information, and facilitating the delivery of additional information from NGA offices elsewhere. Because they had assets in place and focused on the region, NGA provided the first comprehensive overview of the damage resulting from the hurricane and flood. NGA merged imagery with other information daily, creating hundreds of intelligence products to support decision making by response professionals. NGA assessments were multi-dimensional, timely, relevant, and continuous.[46]

These same geographic information systems analysts provided decision makers with quantitative data to enable recovery efforts at all levels of government.

The decision-makers used GEOINT to direct the actions of first responders. After Hurricane Katrina's landfall, local, state, and federal government found a way to use geographic information systems to enable recovery operations. When rescue, cleanup, and restoration began to make its way into New Orleans, some less heralded geographic information systems experts mapped the situation digitally and provided critically needed accurate maps to first responders. Geographic information systems technology enabled decision-makers at the federal, state, and local level to assign the right equipment, organize inventories, evacuate communities, and repair and restore infrastructure and crucial services. Geographic information systems mapping software aided search and rescue units in locating isolated people throughout the city. Employing GEOINT to direct the actions of first responders as in the aforementioned cases represent examples of commander's visualization in execution and assessment.

The GEOINT products facilitated a citywide coordination effort to rescue stranded residents. Medical staff used geographic information systems to select areas from which medical facilities could function unmolested by hurricane effects. Relief officials used data obtained from geographic information systems to position food distribute centers in areas near dense populations but away from unsanitary parts of the city. Public works departments used GEOINT to coordinate the efforts of public works personnel to restore water, sewer, and other city services. Law

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[46] Ibid, 131

enforcement monitored neighborhoods better and established safe zones block by city block.[47] GEOINT helped enable all the aforementioned actions by first responders. Unfortunately, first responders at all levels of government performed these operations independently of each other due to the absence of unity of effort in situational understanding. The absence of a central authority to track and synchronize the efforts of local, state, and federal agencies revealed a gap in unity of effort. Failure to link all government agencies to a common GEOINT database resulted in a lack of shared and situational understanding. Visualization of shared understanding allows for better synchronization of recovery efforts and at a faster pace.

The products developed by the U.S. Army Corps of Engineers (USACE) just prior to Hurricane Katrina's landfall provided the best visual portrayal of how GEOINT positively influences preparedness and response for local, state, and federal agencies. USACE products developed just prior to and after landfall of Hurricane Katrina focused on the "big picture" resource requirements.[48] USACE reveals important resource requirements such as the required truckloads of ice and water to support the population concentrations within the affected areas.[49] In addition, USACE used hurricane-modeling diagrams to depict expected debris models based on anticipated rainfall and wind velocity where the Hurricane makes landfall.[50] Officials described the geographic information products as a first step toward recovery efforts.

> Geographic information products produced running estimates that assessed post-disaster damage, rescue and recovery operations, building temporary homes, removing debris, pumping floodwater and identifying affected communities. Estimates such as these enhance the decision-makers ability to visualize operations during execution and throughout the assessment process. For rescue and recovery, geographic information system teams gathered data on the location

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[47] Craig Morgan. "*GIS Supports Hurricane Response*." ArcNews. ESRI Press. Redlands, CA. 2005. http://www.esri.com/news/arcnews/fall05articles/gis-supports.html Accessed 17 Feb 2009.

[48] U.S. Army Corps of Engineers. "*CEERP:Disaster Impact Models and Mapping:Past Storm Events.*"Corps of Engineers Emergency Response Portal. 2005 https://eportal.usace.army.mil/sites/ENGLink/DisasterImpactModels slide 1Accessed 21 February 2009.

[49] Ibid, slides 2-6

[50] Ibid, slides 7-12

> of hurricane victims and fed information into a database that tracked by name, who was rescued and when. [51]

USACE produce the only modeling type GEOINT products that assisted the first responders' rescue and recovery efforts after the hurricane made landfall.

Federal, state, and local organizations failed to use valuable hurricane modeling information provided by USACE in a planning and preparation role for Hurricane Katrina's eminent arrival. Instead, local, state, and federal stovepipe response used USACE's hurricane modeling data for consequence management and disaster response. The aforementioned examples emphasize GEOINT's potential to provide the decision-maker a tool to facilitate visualization in execution and assessment. If used appropriately, GEOINT modeling provides a decision-maker with the ability to visualize a potential outcome that may require the coordination of assets or resources prior to the event occurring. Government will remain unsynchronized without a common operating picture for visualization in situational understanding. Geographic information systems technology assists decision-makers in reacting to a post hurricane landfall but through its modeling capabilities, the decision-makers can prepare for unexpected contingencies and position resources to assist recovery efforts. The Hurricane Pam exercise provides just such an example.

Hurricane "Pam"

Hurricane "Pam" is one of the under publicized training exercise that was intended to test and inform response plans. Officials at the local, state, and federal levels of Louisiana and Federal Emergency Management Agency (FEMA) in July 2004 engaged in this test of their

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[51] Geoplace.com. "*Corps of Engineers Create Maps For Hurricane Relief*." Geoplace: Government Connection, 2005. http://www.geoplace.com/ME2/dirmod.asp?sid=&nm=&type=Publishing&mod=Publications%3A%3AArticle&mid=8F3A7027421841978F18BE895F87F791&tier=4&id=3F1301FE13004D11B1DCC6E94ECF3236. Accessed 21 February 2009.

preparedness.[52] The FEMA contracted the simulated event to a privately owned Baton Rouge enterprise known as Innovative Emergency Management (IEM) Inc. IEM was selected for its ability to use advanced Geographic Information Systems modeling to evaluate threats and develop risk based solutions.[53] The purpose of the exercise was to help officials develop joint response plans for a catastrophic hurricane in Louisiana.[54] The exercise tested the following:

> IEM's approach to scenario-based catastrophic planning brings together planners and operational personnel from multiple jurisdictions, agencies, and organizations to draft actionable plans and plan updates on the spot. Using science-based modeling and subject-matter experts—emergency planners, scientists, exercise specialists, and human behavioral specialists, and others—IEM creates a plausible catastrophic scenario, including consequences and challenges for response.[55]

IEM combined 3-D Modeling, cartography and spatial analysis with population estimates and demographic analysis to examine the potential effects of a category three hurricane striking the city of New Orleans and the Louisiana coast. IEM utilized decision support systems geospatially enabled simulation modeling. Decision support system simulation modeling is very similar to the military's decision support template and course of action analysis tools but incorporate simulation technology to determine results. The result was an exercise that closely resembled the damage produced by Hurricane Katrina.[56]

The Hurricane Pam exercise involved response by all levels of government and produced a number of observations. Two years later the U.S. House of Representatives published a report titled, *A Failure of Initiative: Final Report of the Select Bipartisan Committee to Investigate the*

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[52] U.S. House of Representatives. *A Failure of Initiative: Final Report of the Select Bipartisan Committee to Investigate the Preparation for and Response to Hurricane Katrina.* U.S. Government Printing Office, Washington D.C. 2006 pg 81

[53] Ibid, 81

[54] Ibid, 81

[55] Innovative Emergency Management Inc."*Homeland Security and Management: Catastrophic Disaster Planning.*" IEM Publishing, Baton Rouge, LA. 2008 http://www.iem.com/CatastrophicDisasterPlanning.php Accessed 22 February 2009.

[56] Innovative Emergency Managment, Inc. "*Homeland Security and Management: GIS/Geospatial Technology.*" IEM Publishing, Baton Rouge, LA. 2008. http://www.iem.com/GIS.php Accessed 22 February 2009.

Preparation for and Response to Hurricane Katrina.[57] Unfortunately, planners and decision makers at all levels ignored or chose to overlook data produced by IEM's Hurricane "Pam" exercise. Using GEOINT modeling capabilities, Hurricane "Pam" revealed the potential impact of a category three hurricane striking the city of New Orleans. The data provided by IEM to FEMA and to the state of local officials of Lousiana and the city of New Orleans depicted a situation that was more than adequate to assess the adequacy of National Response Plan. The government's failure to use IEM data to exercise the National Response Plan is analogous to a military commander who disregards the results of course of action analysis. Because the government did not recognize the value of the IEM data, GEOINT's primary role during Hurricance Katrina was limited to support for first responders in consequence management and disaster response.

GEOINT's Role: Post Landfall Hurricane Katrina

GEOINT capabilities provide incident commanders and first responders a comprehensive, continuously updated understanding of what is happening before, during and after an emergency.[58] GEOINT products generated by geographic information systems experts aided in the creation of a common operating picture (COP).[59] All levels of government used GEOINT's COP to synchronize local and state rescue efforts to prevent duplicating the efforts of other federal agencies. The intersection of strategic basemaps, critical infrastructure, intelligence

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[57] U.S. House of Representatives. *A Failure of Initiative: Final Report of the Select Bipartisan Committee to Investigate the Preparation for and Response to Hurricane Katrina.*81

[58] ESRI. "*Homeland Security: GIS for Preparing and Protecting a Nation.*" ESRI Publications. Redlands, CA 2007. http://www.esri.com/industries/federal/gis-business/brochures.html. Accessed 17 Feb 2009.

[59] ESRI. "*GIS Supporting the Homeland Security Mission*" An ESRI White Paper. Redlands, CA 2007 pg 4. A Common Operational Picture (COP) as defined by GIS is the effort that ensures all individuals and teams invovled in operations or command have the same information.

data, and emergency operations creates the information management construct for a COP.[60] A basemap provides a comprehensive view of activities and situations for better decision making.[61] GEOINT's fusion of the aforementioned components into a COP supported the efforts of first responders during consequence management when nothing seemed to be going right.

During the aftermath of Hurricane Katrina, first responders scrambled to understand the magnitude of the situation. Local and national media provided the first complete images of the massive damage to New Orleans. In addition, geographic information systems software was used to generate thousands of maps for both "big picture" decision support and ground-level response.[62] Maps showed aid stations, damaged buildings, communications networks, medical facilities, power outages, and last known positions of missing persons. The same data layered maps aided search and rescue operations by depicting road closures and locations of safe water sources. NGA and GIS Corps[63] coordinated the efforts of hundreds of geographic information systems experts who worked around the clock generating maps to enhance overall situational awareness for incident commanders. The customized maps produced by geographic information systems experts and volunteers assisted emergency crews throughout the city of New Orleans.[64] Mobile mapping captured data in the field. The data permitted damage assessment and provided the agency staff with estimates that in turn enabled agencies reaction to changing conditions. Such information formed a common operating picture that was vital to officials setting priorities for scarce resources.[65] Because all levels of government failed to create centralized GEOINT common operating picture stored in a single database the responding agencies had no common

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[60] Ibid, 4. Basemap is term used by a geographic information systems analyst to describe a digital map layered with organized data that is turned on or off based on the needs of the decision-maker.

[61] Ibid, 4

[62] Morgan, 1

[63] Mike Kataoka. "GIS for Homeland Security: Case Studies in GIS." Redlands, CA *ESRI Press.* 2007 pg 25. GIS Corps, established in 2003 as an army of the Urban and Regional Information System Association (URISA), mobilized and coordiated hundreds of GIS volunteers along the Gulf Coast.

[64] Ibid, 26

[65] Ibid, 27

understanding of the situation. The government's collective failure to coordinate interdependently the emergency operations centers (EOC) throughout New Orleans are examples of a lack of visualization in execution and assessment.

The functions of Emergency Operations Centers (EOC) during disaster response are examples of where a GEOINT COP improves the process of the recovery. An emergency operations center provides a central point of control and coordination during major events and emergencies.[66] Command center personnel must synthesize information and make rapid decisions as events unfold. GEOINT enabled by geographic information systems technology supplies EOC personnel with data and information to support situational awareness. When integrated and queried together, GEOINT data can provide EOC personnel up-to-date information on the status of assets and resources when responding to incidents.[67] Although EOCs were established well before Hurricane Katrina made landfall heavy winds and flood rendered inoperable cell phone and landline communication. Each EOC's operated in a vacuum, incapable of synchronizing their efforts or efficiently requesting more resources once the damage had exceeded the local and state capabilities. Satellite-based geospatial imagery combined with county and city maps allowed EOCs to regain situational awareness and minimize redundant efforts throughout the affected area.[68] Since EOCs are equivalent to military tactical operation centers, they serve as the primary managers of decision and information dissemination. Since communication between the EOCs is vital to synchronization efforts throughout an area of operation, the commander ensures his picture of the environment nests with those of subordinate units. Failure to synchronize these efforts among multiple EOCs results in a breakdown in the visualization of situational understanding, execution, and assessment.

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[66] ESRI. "Mapping the Future of Public Safety: GIS for Disaster and Emergency Management." *ESRI brochure*. Redlands, CA 2007. pg 9

[67] Ibid, 9

[68] Craig Morgan. "GIS Supports Hurricane Response." *ArcNews. ESRI Press*. Redlands, CA. 2005. http://www.esri.com/news/arcnews/fall05articles/gis-supports.html Accessed 17 Feb 2009.

GEOINT aids in developing community emergency response plans for local, state, and federal agencies. All emergencies, whether caused by nature or people, begin locally and elevate to regional, state, or national levels depending on the severity, complexity, and size of the event.[69] Hurricane Katrina is the perfect example of such an emergency. During Hurricane Katrina, emergency managers needed the right information at the right time to deploy resources, implement evacuation plans, and establish medical aid stations.[70] During the process of recovery, GEOINT technology revealed many functional facilities, resources, and evacuation routes. Decision makers failed to exploit geographic information systems because they did not ask the right questions to guide data analysts. As a result, improper use of geographic information systems technology indirectly portrayed the government's response as slow and mediocre. Employing GEOINT in disaster response and consequence management underutilizes the full potential of the technology. In the commander's visualization through operations and execution, the GEOINT analytical process is analogous to failing to determine if the science of a developed course of action passes the feasible, acceptable, and suitable (FAS) test. During Hurricane Katrina, GEOINT's role in disaster response aided in recovery efforts and saved lives. Government's inability to exploit GEOINT's simulation and modeling capabilities negatively impacted all agencies preparedness and ability to respond after landfall.

[69] ESRI. "Mapping the Future of Public Safety: GIS for Community Safety and Security." *ESRI brochure.* Redlands, CA 2007. pg 8

[70] Ibid, 8

Mission Visualization: Hurricane Katrina

GEOINT's ability to create a realistic, interactive scenario that depicts a four dimensional area may have been useful to planners and decision-makers in preparation for Hurricane Katrina's arrival. The Department of Homeland Security is responsible for coordinating the federal response to natural disasters. DHS focuses on protecting the American people, critical infrastructure, and key resources.[71] DHS performs a variety of tasks that require short-and long-range planning, including risk assessment, mitigation, preparedness, response, and recovery.[72] The modeling capabilities provided by GEOINT enable shared understanding, assessment, and response for all levels of government. The definition of the process of geographic information systems modeling is emulating how the terrain and weather may affect the operations in a specific area over time.[73]

Through modeling potential or evolving events, GEOINT technology can help emergency managers visualize the extent and impact of events. GEOINT information sharing allows agencies to anticipate the effects disasters on populations and infrastructure. GEOINT modeling exercises prepare multiple at various levels of government and often engage include volunteers from the private sector. After creating basic GEOINT imagery model of an area, the image can be accessed and modified by multiple GEOINT analysts to produce different simulations of the same event. GEOINT modeling allows the planner and decision-maker to prepare for and train multiple contingencies while exploiting the collective expertise of multiple GEOINT analysts. Various agencies and private organizations can coordinate and cooperate the planning for and executing the appropriate response based on multiple outcomes. Modeling

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[71] Homeland Security Council. "National Strategy Fort Homeland Security." *White House Publishing*. Washington, D.C. 2007. pg 31

[72] ESRI. "Mapping the Future of Public Safety: GIS for Community Safety and Security." *ESRI brochure.* Redlands, CA 2007. pg 8

[73] David J. Macguire, Michael Batty, Michael F. Goodchild. GIS, Spatial and Modeling. *ESRI*. Redlands, CA 2005 pg1

efforts enable realistic training exercises that test the limits of organizational capabilities at at a fraction cost of a full-scale rehearsal. Several modeling programs developed by private firms use geographic information systems to determine the potential effects of hurricanes prior to landfall. Analytical programs can make estimates of water and wind damage, and even estimate casualty figures based on the population within the urban area. After Hurricane Katrina, the local, state, and federal agencies invested heavily in analysis software to predict disaster effects and to assist in planning the response to future natural disasters. Analysis software programs come with varying degrees of sophistication and costs, but all programs help to enable a comprehensive response to future disasters such as Hurricane Katrina.

An ArcGIS solution for emergency management connects information systems designed to support the operations of small, midsized, and large government agencies. ArcGIS programs reside predominately at the state and federal level and are used to analyze potential emergencies, to mitigate consequences, and coordinate the response to those emergencies[74] ArcGIS integrates the collection of geographic information systems software products that provide a basic set of programs for spatial analysis, data management, and mapping.[75] ArcGIS provides, through ArcCatalog, a system for gathering and organizing spatial data and related information.[76] More specifically, the Situational Awareness Bundle is a newly developed add-in component of ArcGIS that helps organizations understands and assess how events, such as a hurricane, will influence operations. The Situational Awareness Bundle package for ArcGIS allows the decision-maker, to improve his organization's internal staff processes.: Through collaboration, staff processes improve when incorporating the expertise of other analysts in multiple locations.

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[74] ESRI. "Homeland Security: GIS for Preparing and Protecting a Nation." *ESRI Publications*. Redlands, CA 2007. http://www.esri.com/industries/federal/gis-business/brochures.html. Accessed 17 February 2009.

[75] ESRI GIS and Mapping Software. " ArcGIS: A Complete Integrated System." *ESRI Publications.* Redlands, CA 2005. http://www.esri.com/software/arcgis/ Accessed 17 February 2009

[76] ESRI GIS and Mapping Software. " ESRI Brochure. ArcGIS: A Complete Integrated System." *ESRI Publications*. Redlands, CA 2005. pg 2.

Planning, preparing, and responding to an emergency situation caused by a natural or man-made disaster. Incidents such as these require the collaboration of many different agencies and departments from both the public and private sectors.[77]

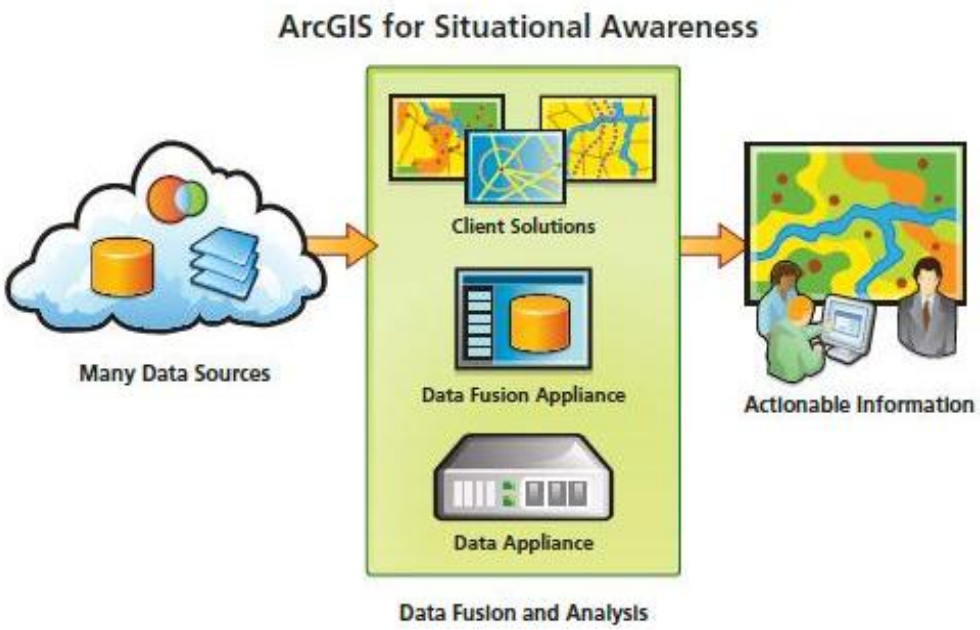

Figure 2: ArcGIS for Situational Awareness helps turn data into actionable information

ArcGIS databases used by private and public agencies in mission planning synchronize operations and improve shared understanding. A geographic information systems database allows the analyst to assess risk and hazards to population, property, and natural resources. The analyst is able to integrate data and alter the size and scale of an emergency to investigate a range of conditions and consequences. The subsequent visual display informs the decision maker who then uses the information to assign priorities for search and rescue tasks.[78] In examining the effects of Hurricane Katrina's impact on the population of New Orleans, it is easy to understand why so many residents could not evacuate after the mandatory order. When New Orleans' demography was assessed, geographic information systems revealed that twenty-five to thirty percent of the

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[77] (ArcNews Online. "New ArcGIS Situational Bundle Helps Planning and Response." *ESRI Publishing*. Redlands,CA 2008. http://www.esri.com/news/arcnews/winter0809articles/new-arcgis-sab.html Accessed 17 February 2009.

[78] Ibid, http://www.esri.com/news/arcnews/winter0809articles/new-arcgis-sab.html Accessed 17 February 2009.

population lacked the means to evacuate.[79] Geographic information systems can query population densities by age, and illness, and public transportation routes through links with state and local census databases. GEOINT demographic data informs decision-makers and drives priorities for planning and resource allocation. Because federal, state, and local officials' failed to understand the demography of New Orleans and the physical environment they did not anticipate the post-landfall conditions and, thus, made a poor decision when they delayed the evacuation and they made equally poor decision concerning the positioning of support.[80]Organizations that fail to use geographic information systems to forecast requirements are not providing the decision maker the information needed to mobilize city officials. Thus, GEOINT is an important means to achieve situational understanding.

HAZUS-MH, is another type analytical extension, that can be added to ArcGIS software to produce damage and loss estimates based on a scientifically defendable scenario. FEMA uses HAZUS-MH to mitigate hazards and protect lives and property from the devastating effects of natural disasters. HAZUS-MH provides individuals, businesses, and communities that use ArcGIS analytical tools to develop and assess plans to mitigate hazards and prevent losses.[81] Although HAZUS-MH focuses more or potential losses, it can assist the NORTHCOM commander's decision-making by providing a variety of estimates.

> Estimating losses is essential to decision-making at all levels of government, providing a basis for developing mitigation plans and policies, emergency preparedness, and response and recovery planning. The HAZUS-MH Hurricane Model and Flood Model will allow users to estimate hurricane winds and

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[79] Constantin Andronache, Mani Dalgin, Rudolph Hon, Rudolph.Barbara Mento. "Mapping Hurricane Katrina With GIS." *ESRI Users Group Conference: Technical Paper*. Chesnutt Hills, MA 2006 pg 16

[80] Ibid, 16

[81] Doug Bausch. "HAZUS: FEMA's GIS-Based Risk Assessment Tool." *GIS Development.net.* 2003. http://www.gisdevelopment.net/proceedings/gita/2003/disman/dism09pf.htm Accessed 21 February 2009.

potential water damage and the subsequent loss to residential, commercial, and industrial buildings.[82]

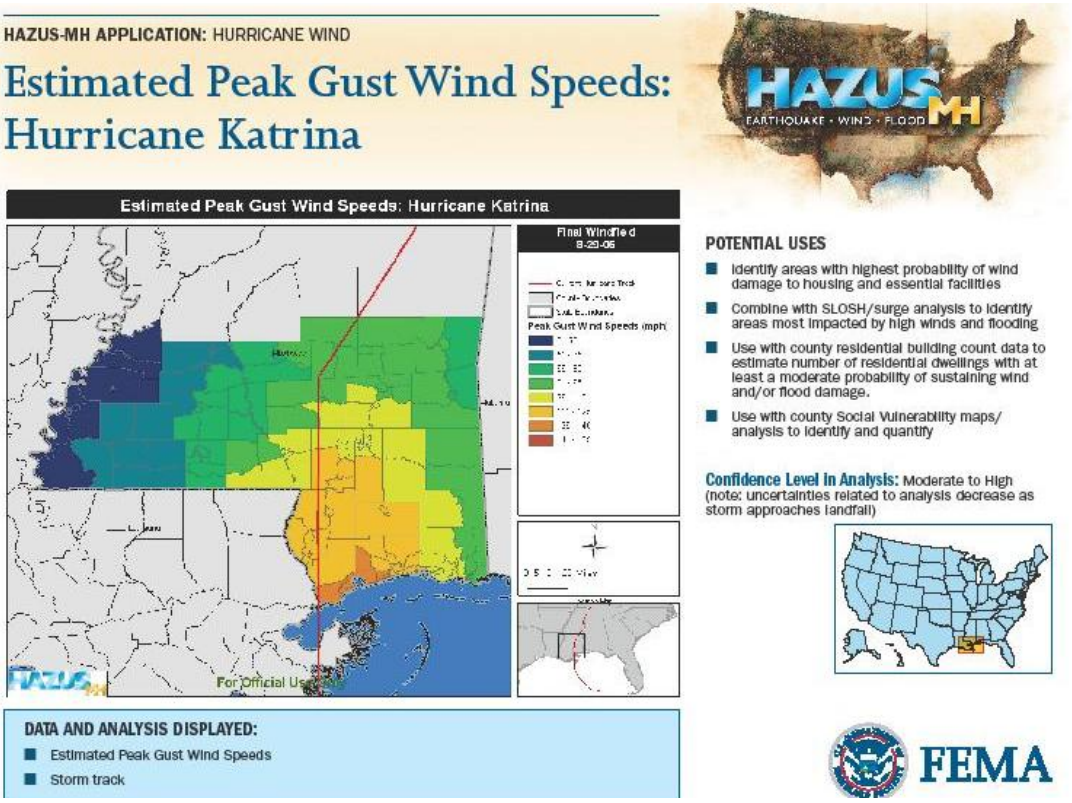

Figure 3: HAZUS-MH provides federal and state agencies potential damage estimates.

Properly used, HAZUS-MH provides the means to determine where to expect the most severe damage. The software analyzes a structure's composition and integrity and measures its ability to withstand a hurricane's potential wind speed. Extensive national databases are embedded within HAZUS-MH. The database contains information on the population demography the size and area for different buildings, occupancy rates, and the number and location of bridges.[83] Such information is valuable for estimating how many residents will require temporary shelter. Members of a planning team can extend planning timelines based on estimates of work required to restore infrastructure. HAZUS-MH forecasts enabled by GEOINT allow the commander or

[82] Ibid, http://www.gisdevelopment.net/proceedings/gita/2003/disman/dism09pf.htm Accessed 21 February 2009.

[83] Federal Emergency Management Agency. "HAZUS-MH MR3 Technical Manual."Washington, D.C.,. 2004. pg xi) *FEMA Distribution Center*

decision-maker to visualize the initial assessment through the development of a running estimate. Forecasts and estimates make possible timely requests for additional resources if the commander's requirements exceed current capabilities. Forecasts and estimates provide the decision maker or commander a baseline from which to visualize how disaster response will stress capabilities. As a commander visualizes execution, forecasts and estimates can be adjusted to reflect changes in conditions.

The aforementioned software programs draw upon the collective city, state, and federal urban city and county planning databases. The process of urban sprawl has caused urban city planners to update urban data and that data has subsequently become available to emergency preparedness organizations. The more local and state information is added to existing geographic information systems databases the more realistic planning scenarios become. Subsequently, more data available to more agencies increases the likelihood of accurately depicting relevant training scenarios for all organizations involved. With more data available to the analyst, GEOINT improves planning, operations, communications, and decision-making. The GEOINT database links the federal, state, and local levels of government through access to shared data. GEOINT software's compatibility allows for interpretability for organizations like the military that utilize other types of analysis programs. The decision-maker and planning staff need only to ask the right questions to reduce the time-consuming process of filtering through data. Faster and better decisions during an emergency can save lives.[84]GEOINT can aid in the process of decision-making for the JTF or NORTHCOM commander in accordance the DOD's role of the National Response Plan. As previously stated, planners need only learn to ask the right questions.

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[84] National Defense Research Institute. *Installation Mapping Enables Many Missions: The Benefits of and Barriers to Sharing Geospatial Data Assets.* Monograph, Santa Monica, CA: The RAND Corporation, 2007.

Communicating Requirements for GEOINT Modeling

GEOINT demands a new approach to recognize spatial literacy along with other basic abilities. In elementary and high schools, maps, pictures, and spatial data need to rank with numbers, text, and logic.[85] Communicating requirements from planner to GEOINT analyst remains a challenge. Military planners tend to be generalists within their respective career field and few military planners have experience supporting to civil authorities. The need for planners to communicate specific requirements to the GEOINT analyst better comes from the need to use GEOINT modeling capabilities to visualize the impacts of an event. The planner must develop a line a questioning that informs the sequencing of operations.

In the case of Hurricane Katrina, specific questions required answers to address the impacts of the hurricane on the infrastructure and population. GEOINT products displayed flooding and its impacts on rescue and relief operations. Asking the analyst to model the effects of a hurricane on a city reveals multiple questions and associate tasks. Each question or task may require additional information or resources. For example, the planner can ask the analyst to identify routes in and out of the city of New Orleans that will not be affected by a 20-foot storm surge. A follow-up question might ask what parish locations are isolated from these routes due to their proximity to levees or elevation. Finally, within the identified parishes, the planner might want to know how many people live there and the analyst would then provide an estimate of population densities by city block. The answers to the aforementioned questions might serve as basis for deciding upon resource requirements for initial staging as well as designated primary and alternate routes to and from designated locations. Questions such as these are vital for planners to communicate to analysts. Failure to use GEOINT's modeling potential to help determine what questions the planner needs to ask will limit GEOINT's use to disaster response.

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[85] Michael F.Goodchild, "The Fourth R? Rethinking GIS Education." *ArcNews Magazine. ESRI Publishing,* Redlands, CA 2006 pg 3

In addition to these questions, the modeling capabilities of GEOINT extend further than estimating how the hurricane affects the impacted area. More precisely, GEOINT analysts can examine what infrastructure within the impacted area may compound the hurricane's effects if steps are not taken to mitigate the potential hazards. For example, chemical contamination can complicate situation either by incapacitating the first responders or by hindering the arrival of emergency teams. GEOINT provides planners a means to estimate a variety of likely situations and to identify what infrastructure components might threaten response effort. Modeling hurricanes with GEOINT allows planners to interdict potential affects by either removing the threat or staging assets to deal with the potential problem.

Understanding the social, political, cultural, economic, and demographic elements remains are also important for anticipating how a specific population will react when confronted with a natural disaster.[86] GEOINT modeling knowledge[87] could have been employed to potentially predict which neighborhoods in New Orleans required evacuation assistance. Had queries been made about which parts of the city were most dependent on public transportation the planners might have identified both the number of vehicles needed to conduct an evacuation and the best place to stage that resources. Additional queries can identify medical facilities, assisted living centers, and detention facilities all of which require coordinated evacuation plans assisted by local, state, or federal agencies. Further analysis will reveal routes in an out of these impacted neighborhoods based on analysis of potential flooding, the study of debris fields, and the projected winds effects on structures. A GEOINT generated map is critical to understand

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[86] Ibid, Brown 2008

[87] Philip Pridmore Brown,. Information Capture: Integrate Semantic Technology, Knowledge Modeling and Location-Based Intelligence. Geoplace.com: The Authoritative Resource For Spatial Matters. 2008. http://www.geoplace.com/ME2/dirmod.asp?sid=119CFE3ACE2A48319AA7DE6A39B80D66&nm=News&type=Publishing&mod=Publications%3A%3AArticle&mid=8F3A7027421841978F18BE895F87F791&tier=4&id=385CEF461A0A43A09F7D485989FC0977. Accessed 2 March 2009. Modeling Knowledge is a set of concepts and relationships. It incorporates rules to determine where concepts reside and what they mean.

patterns of activity, jurisdictions and spheres of influence- essentially the geographic model.[88] Using GEOINT modeling informs the decision-maker or commander's visualization in operations. Modeling assists the commander in the development of contingency plans, branches, and sequels. GEOINT modeling varies based on the specific inputs and hurricane size and strength. Modeling informs the planning and execution process and subsequently a commander's visualization during operations.

In preparation for the 2008 hurricane season, NGA partnered with the USNORTHCOM to conduct the Positive Response Command Post Exercise.[89] That exercise tested the end-to-end GEOINT synchronization between USNORTHCOM and NGA in preparation for the 2008 hurricane season.[90] GEOINT capabilities are now being utilized for more than consequence management. Joint Task Force Civil Support, the consequence management, component of NORTHCOM is utilizing GEOINT to obtain a comprehensive view of the operational environment prior to a potential disaster.[91] JTF-CS supported by NGA draws on an existing national database. The database locates chemical plants, hazardous material facilities, medical service, and other critical infrastructure. The data is used to create a map of the area in which JTF-CS will operate.[92] Civil authorities at the state and local levels use the same capability through open-source databases and are more synchronized and less redundant than in previous exercises. As previously stated, GEOINT's analytical capabilities allow various agencies at multiple levels to work together by sharing data. The intent is to align tasking, collection, production, exploitation and dissemination to combatant commander. JTF-CS and supported civil authorities used GEOINT analytical capabilities to get the right information to the right people at

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[88] Ibid, Brown 2008

[89] Robert B. Murrett Admiral. "On My Mind: Disaster Preparation Relief and Recovery." Pathfinder SEP-OCT 2008. p ii.

[90] Ibid, p ii

[91] Roy Hawkins. "Consequence Management Goal of NORTHCOM GIS." *Pathfinder: The Geospatial Intelligence Magazine.* July-August 2006. p. 20-22.

[92] Ibid, 21

the right time.[93] NORTHCOM and the NGA, in support of state and local officials, used GEOINT to support all fifteen Emergency Support Functions (ESFs) as outlined in Appendix D of Joint Publication 3-28.[94]The key data component of GEOINT's ability to support all fifteen ESF is best described through a term known throughout the GEOINT and geographic information systems community as geoprocessing. Using GEOINT to model a training simulation exercise, NORTHCOM and state and local agencies exercised the functions and coordination between command posts to inform the commander's and civilian decision-makers visualization through execution and assessment.

The fundamental purpose of geoprocessing is to allow the user to automate geographic information systems tasks.[95] Geoprocessing supports the automation of workflows by providing a rich set of tools and a mechanism to combine a sequence of operations using models and scripts.[96]An ESRI White Paper produced in May of 2007, summarizes the capabilities of Geoprocessing when used to support strategic and operational planning:

> Geoprocessing is performed during the analysis and modeling phases of strategic planning. Geoprocessing is essentially the systematic work performed by GIS analytical tools, such as ArcGIS and identifies the impacts of an event on a particular community, neighborhood, or critical infrastructure.[97]

Geographic information systems enhance virtual and physical response exercises by geographically displaying threats and hazards in conjunction with other geographic data. The linkage of multiple GIS databases, such as population density, critical infrastructure locations, resource placement/deployment locations, and transportation routes, to a layered map provides

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[93] Murrett, 3

[94] Headquarters, Department of Defense. *Joint Publication 3-28 Civil Support*. U.S. Government Printing Office. 2007. Appendix D-7

[95] ESRI Developer Network. *Documentation Library*. July 31, 2008. http://edndoc.esri.com/arcobjects/9.2/net/shared/geoprocessing/geoprocessing/what_is_geoprocessing_qst_.htm (accessed March 2, 2009).

[96] Ibid, http://edndoc.esri.com/arcobjects/9.2/net/shared/geoprocessing/geoprocessing/what_is_geoprocessing_qst_.htm (accessed March 2, 2009).

[97] ESRI. "GIS Supporting the Homeland Security Mission" *An ESRI White Paper.* Redlands, CA pg. 3. 2007

better understanding of risks to life, health, and property as well as economic impacts. The function of geoprocessing is to the visualize data in the context of a map. Modeling with geoprocessing allows geographic information systems analysts to create a scenario and visualize the potential effects on a community. Geoprocessing provides the commanders with several situational templates that a staff can use to train response preparation and planning. When combined with the limitations inherent when operating domestically, federal forces supporting civil authorities can exercise multiple scenarios without a physical footprint in the simulated area.

Response exercises serve as one of the primary means for preparing all organizations within the NRF to work together more efficiently. When a natural disaster is eminent each of government response establishes a command posts to coordinate and synchronize the efforts of all those involved. Since all disasters are local, response begins initially at the local level and within the NRF works its way up to the federal level. NORTHCOM or JTF-CS Commander assesses both the local and state response capabilities to ensure they can handle the potential consequences of the specific natural disaster they are facing. Situational understanding leads to the identification of resources available to support the local and state response. During response exercises, GEOINT, informed by geoprocessing, can play a vital role in identifying threats and hazards that may overwhelm the local and state agencies. Geoprocessing forecasts allow the NORTHCOM or JTF-CS commander to anticipate potential problems through the development of tactical incident plan that mirrors those of the local and state agencies.

> Geographic information systems is effective at creating the briefing map as well as other important incident maps including: [98]
>
> - Incident transportation maps
> - Incident perimeter and incident command system (ICS) branches, divisions, and facilities
> - Logistical supply points, drop points, and fueling areas

[98] An ESRI White Paper. "GIS Supporting the Homeland Security Mission." *ESRI White Paper*. Redlands, CA: ESRI, pg 6. May 1, 2007.

- Incident air traffic patterns
- Incident models and predictions
- Hazard areas[99]

During exercises, incident management personnel play a vital role in understanding how events may unfold, potential consequences, and effective actions necessary to control an incident.[100] Civil Support response exercises using GEOINT modeling capabilities provide the military with the best tools to support planning and operations.

GEOINT modeling provides decision-makers and commanders with a comprehensive understanding of the situation before it occurs. The Heritage Foundation published an assessment of the military support to civil authorities. Alane Kochems concluded that Hurricane Katrina was a test of the nation's preparedness for a catastrophic event. As expected, the results of that test were troubling. Hurricane Katrina highlighted the absence of a comprehensive, all-hazards national system to respond to catastrophic events. A national GEOINT database maintained by the NGA and supported through partnerships with private companies like ESRI, provides all levels of government and the DOD the tools needed to understand and prepare for future disasters. The aforementioned partnerships support the decision-maker or commander through all stages of commander's visualization. GEOINT modeling, in particular, exercises the commander's ability to attain shared situational understanding during exercises. Modeling allows for training that begins at visualization through operations and continues during execution. Modeling creates conditions that supports working through potential decisions a commander must make in response to a unique situation. Therefore, a commander uses GEOINT modeling to assess the effects and consequences of a particular decision throughout all stages of a commander's visualization.

[99] Ibid, 6
[100] Ibid, 6

Conclusion

GEOINT is the exploitation and analysis of imagery and geospatial information to describe, assess, and visually depict physical features and geographically referenced activities on the Earth.[101] GEOINT is a combat multiplier that informs mission command for the decision-maker or commander who employs its capabilities.[102] Throughout this process, GEOINT supports the commander's visualization through situational understanding, operations, and execution, while assessing operations during all stages of mission command. With GEOINT, the process of visualizing throughout all phases of planning and execution occurs faster because a picture is the fastest way to communicate spatial information. The combining imagery and imagery intelligence with a spatial database provides the means to answer questions about the operational environment without physically occupying the actual terrain.

In the case of Hurricane Katrina, all levels of government and NORTHCOM used GEOINT technology in support of disaster response and consequence management. GEOINT guided the efforts of Emergency Operation Centers and first responders while it also supported search and rescue, and the restoration of infrastructure throughout the city of New Orleans. While useful, limiting GEOINT's role to consequence management fails to exploit GEOINT's valuable modeling capabilities. IEM provided local, state, and federal officials with an estimate of what a category three hurricane striking New Orleans would do to inform preparation and response planning. Decision-makers at all levels failed to exploit the lessons of exercise Hurricane "Pam" and missed an opportunity to use existing information that could have better synchronized recovery efforts.

In Spring of 2008, the Positive Response Command Post Exercise, tested the coordination capabilities of NORTHCOM, NGA, and multiple state and local Emergency

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[101] Ibid, vii

[102] Department of the Army, Headquarters. *FM 3-0 Operations.* Washington, D.C., 2008. 5-2, 5-3.

Operation Centers in preparation for the 2008 Hurricane season. Lessons learned from Hurricane Katrina provided an opportunity to examine how shared understanding can improve coordination among all concerned organization. The Positive Response exercise required all agencies to respond to a specific natural disaster in accordance with the National Response Framework. All organizations used ArcGIS software and geoprocessing to share information and respond accordingly. The exercise concluded with each organization understanding their specific roles when responding to a natural or man-made disaster. Since GEOINT modeling capabilities could support all fifteen Emergency Support Functions as outlined in JP 3-28, NORTHCOM strengthened its partnership with the NGA to exploit the NGA's robust GEOINT analyst capabilities. State and local governments that participated in the Positive Response Command Post Exercise purchased and integrated ArcGIS software to support maintaining a COP with federal agencies.

Joint and Army planning doctrine recognize GEOINT but the doctrine does not reveal how GEOINT's capabilities can assist the commander with situational understanding. Joint and Army planners in the U.S. Combatant Commands must follow NORTHCOM's lead and exploit GEOINT modeling capabilities in preparing for new and emerging threats. GEOINT enables this process by allowing a commander to visualize the potential consequences of decisions before execution. Additionally, modeling operations within the elements of time and space can assist commanders to link available resources to a location. Modeling potential scenarios challenge the collective experience and creative abilities of any commander and staff. The value in the employment of GEOINT resides in the ability of software tools to model a complex multi-dimensional environment that accurately represents our world.

GEOINT's ability to layer information on a digital map provides the user with a level of analysis unavailable from existing systems. The Command Post of the Future (CPOF), Google Earth, and FALCONVIEW are useful decision support tools, but they only display static data. Using ArcGIS, the GEOINT analyst can create, update, and modify existing GEOINT data.

While systems like CPOF support collaborative planning, they lack the ability to model weather and terrain, and their effects on an environment. The platform itself additionally requires user data input to develop the situation as opposed to ArcGIS that can access information from shared databases. The more information available the faster the commander can visualize the execution of operations throughout mission command.

GEOINT remains an emerging intelligence discipline that if exploited correctly can provide the commander and his staff with a capability that aids the process of commander's visualization. GEOINT begins with the most fundamentally simple, yet important element of any mission, location. Location, more than intelligence, drives how operations will unfold from start to finish. Making decisions based on geography is basic to human thinking. What location will best enable future operations? What will conditions be like upon arrival? How will those conditions affect operations? Questions such as these stress the importance of learning about the environment. By understanding geography and peoples' relationship to location, commanders can improve their ability to synchronize efforts. Lloyd Rowland, Deputy Director of the National Geospatial Agency stated,

> As we move forward and address these challenges, the GEOINT community approaches the biggest leap forward in our tradecraft evolution—the move to predictive analysis. Predictive analysis will allow our mission partners to move quickly to interdict with a greater probability of success through actionable intelligence.[103]

GEOINT can serve as the eyes of our nation and ensure policy makers and the military have the decision advantage.[104] It makes a critical difference in our ability to save lives by protecting our troops, supporting our leaders, ensuring safety at sea and in the air, and keeping America safe.[105] GEOINT is essential to national and homeland security because it enables early warning,

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[103] Barrowman, 18 2007

[104] Robert B.Murrett, Admiral "On My Mind: GEOINT Leads the Way." *Pathfinder: The Geospatial Intelligence Magazine*, 2009: 1.

[105] Ibid, 1

situational awareness and context for all intelligence activity.[106]Much has been written that attempts to codify how the military can improve the ability to understand the environment. Employing GEOINT modeling capabilities to support the commander's visualization in mission command focuses the military on being active in preparing for future threats. With the security of the American people at stake, exploiting GEOINT modeling capabilities is a start in the right direction.

[106] Ibid, 1

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